ICO versus Credit versus Venture Capital Financing under Stochastic Demand: A comment on "Entrepreneurial Incentives and the Role of Initial Coin Offerings" by R. Garratt and M. v. Oordt

Schilling, Linda

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ICO versus Credit versus Venture Capital Financing under Stochastic Demand: A comment on 'Entrepreneurial Incentives and the Role of Initial Coin Offerings' by R. Garratt and M. v. Oordt

Linda Schilling
École Polytechnique

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1 A short overview

The article 'Entrepreneurial Incentives and the Role of Initial Coin Offerings' by Garratt and Oordt (2021) revisits a classical principal-agent problem in corporate finance: How do financing choices of firms and the according firm ownership structure impact effort choices of the management and therefore firm value (Jensen and Meckling, 1976; Myers, 1977). Garratt and Oordt (2021) extend this classic discussion by analyzing initial coin offerings (ICOs) as a startup financing instrument in contrast to classic financing instruments such as debt, (entrepreneurial) equity and venture capital. The paper shows, depending on the firm's characteristics, ICO financing can align the entrepreneur's incentives with those of his investors better or worse, in comparison to venture capital and debt financing. Therefore, the novel ICO financing instrument is a valuable alternative to credit and venture capital also from a social perspective.

In the model, an entrepreneur requires funding to develop a platform on which services and goods are to be supplied and sold. In the context of the paper, ICO financing means that the entrepreneur may create a novel, digital unit of account ('token'), and sells a proportion of these tokens in exchange for fiat money to external investors. Once the platform launches, investors generate a one-shot return on their tokens by selling them for fiat money to platform users at a certain exchange rate. ICO investors are willing to purchase tokens since the entrepreneur commits to accepting only tokens as the medium of exchange on his platform. Garratt and Oordt (2021) proceed by showing that ICO financing may lead to higher effort choices by the entrepreneur than classic debt or venture capital financing.

I find the efficiency comparison of financing choices for entrepreneurial incentives to be a very interesting and important contribution. In this discussion, I shed light on this topic from a different angle. Garratt and Oordt (2021) base their analysis on the simplifying assumption that demand for the platform product realizes once and for all in $t = 1$. This allows Garratt and Oordt (2021) to abstract from token-exchange rate risk. Here, instead, I will allow platform demand to evolve stochastically across time. Moreover, unlike Garratt and Oordt (2021), I analyze the general case where not necessarily all tokens are sold in the market at every point in time. Instead, there can exist token speculation where investors hold on to tokens for a certain period of time, effectively reducing the token supply, or additional tokens can be mined by the entrepreneur, which increases the token supply, even though the latter activity might constitute a breach of contract. By allowing the token supply and product demand to fluctuate across time, the token exchange rate becomes stochastic, causing exchange rate risk to the ICO investors, the entrepreneur, and platform retailers.

In my discussion, I will outline why the consideration of ongoing demand risk and token speculation is key to understanding the risks of ICO financing in contrast to debt and venture capital financing. Much of my note is devoted to generalizing Garratt and Oordt (2021)'s analysis and deriving the equations needed to consider uncertainty. When uncertainty is introduced, I obtain the following results that complement the results in Garratt and Oordt (2021):

- Result Ia: Variation in the token supply is a risk factor to the entrepreneur under ICO financing: The token supply determines the token exchange rate and thus platform revenue. Generically, platform demand is correlated with the token supply such that both impact the exchange rate.

- Result Ib: Ongoing exchange rate variation is harmful to retailers and, therefore, the entrepreneur. Since retailers cannot exchange tokens for fiat money on the spot, they are exposed to changes in the exchange rate. If realized (fiat) prices substantially deviate from the retailer's reservation prices often, retailers will exit the platform and the entrepreneur's source of revenue vanishes.

- Result II:
  (a) Stochastic demand causes default risk under debt financing but does not cause default risk under ICO financing unless platform expenses are fixed costs.
  (b) In contrast to debt financing, ICO financing provides partial insurance against low platform demand realizations. This holds since ICO investors exit at a variable exchange rate while debt investors have a claim on a fixed (fiat) repayment.

- Result III: Under venture capital financing, the entrepreneur loses revenue by shared firm ownership. Under ICO financing, the entrepreneur loses revenue due to continuous exposure to the behavior of token owners, and in particular, token speculation.

- Result IV: Under ICO financing, revenue is non-monotonic in demand across time due to market efficiency. An expected increase in demand leads to an instantaneous increase in revenue today but can also cause strategic changes in the token supply (speculation), which then leads to volatility in the exchange rate and reduced revenue in the future. In contrast, under both venture capital and debt financing, an expected increase in future demand always leads to an expected increase in the entrepreneneur's revenue at the same time period.

I will explain these findings in more detail below.

2 Model

Consider the following generalization of the Garratt and Oordt (2021) model. At time $t = 0$, the entrepreneur seeks to finance a platform by raising money I_0 from investors in the form of debt, venture capital or via an ICO. The prices at which platform products can trade are common knowledge. Let p_s the price at which platform retailers are willing to sell the platform product, and denote by $p \geq p_s$ the customers' valuation for the platform product. As soon as the platform is funded, Garratt and Oordt (2021) assume that the platform demand s realizes observably to all agents in $t = 1$, and then remains fixed forever. Here, assume instead, that there is only a public signal (information) on future demand that arrives in $t = 1$, and affects all agent's beliefs. To save on notation, let $\mathbb{E}_1[s_t]$, $t \geq 2$ the entrepreneur's and investors' symmetric expectation about future demand s_t at time t after having observed information in $t = 1$. Moreover, assume that demand $\{s_t\}_{t \geq 2}$ is an exogenous, stochastic martingale process, evolving across time. This is, I believe, an interesting extension since the entrepreneur will face not only demand risk (and thus credit risk) at the platform launch stage but stochastic demand will translate into ongoing exchange rate risk, in the case of ICO financing. Following Garratt and Oordt (2021), after observing the platform demand, the entrepreneur decides how much unobservable effort e to put for running the platform more cost-efficiently. Let $c(e)$ the per period operating cost for given effort e. Under zero effort, the operating expenses are high c_H for sure, while under high effort, the operating expenses are low c_L, but only with likelihood $\gamma \in (0, 1)$. To simplify the exposition, I make the assumption that under no effort or under unsuccessful effort, the entrepreneur will not launch the platform since operating expenses exceed possible revenue $p - p_s < c_H$. I keep the timing as in Garratt and Oordt (2021): At time zero, the entrepreneur raises I_0 via venture capital, debt, or an ICO. At $t = 1$, information arrives on the stochastic demand process $\{s_t\}_{t \geq 2}$. Given updated beliefs, the entrepreneur decides whether to put effort for lowering the platform expenses. If no effort is put, the platform will not launch, and the game ends. If effort is put, then effort is successful with likelihood γ, in which case the platform is launched in $t = 2$ since per unit of demand, the entrepreneur can generate revenue $p - p_s - c_L > 0$. If effort is not successful, expenses will be high and the platform is not launched. Given the launch, demand s_2 becomes observable, and trade occurs on the platform, revenue realizes, and depending on the financing instrument, the entrepreneur has to make payments to his investors. In the following, we will look at these expected payment streams in detail. Under either financing method, I will assume that the investors, as well as the entrepreneur and retailers, are risk-neutral.

3 Analysis

Following Garratt and Oordt (2021), let us reconsider how the financing method impacts the entrepreneur's effort decision under a stochastic demand process. Intuitively, distinct financing methods generate different shapes of income streams to the entrepreneur, which in return will 'motivate' him to make distinct effort choices at a given demand signal realization.

Deep-Pocketed Entrepreneur (Efficiency Benchmark) If the platform is financed with the entrepreneur's own funds, all returns and costs will accrue to him alone. Given a cost realization $c(e)$ and a risk-free rate r, the random margin m_t that the entrepreneur can charge per period equals $m_t^* = \max(s_t(p - p_s - c(e)), 0)$. If the costs realize high despite effort, then $m^* = 0$ in every period, and the platform is not launched. If the entrepreneur successfully puts effort, then $c(e) = c_L$ and the random period t-margin becomes

$$m_t^* = s_t(p - p_s - c_L) > 0 \tag{1}$$

In $t = 1$, the entrepreneur's incentive constraint for putting high effort becomes

$$\sum_{t=1}^{\infty} \frac{\gamma \overbrace{\mathbb{E}_1[s_{t+1}]}^{=\mathbb{E}_1[s_2]}(p - p_s - c_L)}{(1+r)^t} - \bar{e} \geq 0 \tag{2}$$

We can simplify this condition, because demand is a martingale, $\mathbb{E}_1[s_{t+1}] = \mathbb{E}_1[s_2]$ for all $t > 2$. Thus, the entrepreneur puts effort if and only if expected demand given the information at time $t = 1$ exceeds the efficiency cut-off s^*

$$\mathbb{E}_1[s_2] \geq s^* := \frac{\bar{e}r}{\gamma(p - p_s - c_L)} \tag{3}$$

Allover, if the $t = 1$ information yields that expected demand exceeds the cut-off $\mathbb{E}_1[s_2] > s^*$, the entrepreneur puts effort and the platform launches with likelihood γ (effort is successful). For $\mathbb{E}_1[s_2] < s^*$, the entrepreneur will not put effort, and the platform will not launch for sure.

3.1 ICO Financing

Under ICO financing, the entrepreneur raises an amount $I_0 > 0$ by generating M tokens of which he sells a share $\phi \in (0, 1)$ to investors. ICO investors generate a return if the platform launches in $t = 2$. Then, customers who want to buy platform products are required to purchase tokens from the entrepreneur or ICO investors. This allows ICO investors to exit at the realized token-exchange rate in $t = 2$. Let s_t the realized demand for the platform product in t and M_t is the quantity of tokens that are up for sales in the market in t (token supply). Unlike Garratt and Oordt (2021), I assume here that the token supply M_t is not constant at the quantity M of initially minted tokens but can fluctuate. If $M_t \leq M$, some tokens are held back from the market, potentially due to speculation in the token price. If $M_t > M$, the entrepreneur has mined additional tokens on the side and sells them in the market. I will also assume that such additional mining is not instantly detected so that the platform continues to generate revenue for the entrepreneur. Let S_t the stochastic token exchange rate in t, i.e. the fiat value of one token

$$S_t = \frac{s_t p}{M_t} \tag{4}$$

Due to stochastic demand s_t and a random token supply M_t, there exists ongoing exchange rate risk. In contrast, in Garratt and Oordt (2021), since both the token supply and demand are fixed after $t = 2$, the exchange rate there is known and constant. At a customer valuation of p fiat units per product, platform retailers can charge a price of up to $\frac{p}{S_t}$ tokens. In $t \geq 2$, customers come to the platform, acquire tokens by exchanging p units of fiat for $\frac{p}{S_t}$ tokens on the spot, receive the product and pay by handing over their tokens to retailers, and exit the platform. As in Garratt and Oordt (2021), since retailers can exchange the tokens for fiat money only in the next time period, they require compensation for the lost time value of money. The entrepreneur has to leave retailers with a margin of $\frac{(1+r)p_s}{\mathbb{E}_t[S_{t+1}]}$ tokens per sold platform product which the retailers will exchange in $t + 1$ at the realized exchange rate S_{t+1} for fiat money. This perpetual one-period delay overall reduces the margin to the entrepreneur. His margin in terms of fiat money becomes

$$m^{ICO}_{t+1} = s_t \Bigg(\underbrace{\underbrace{\left(\frac{p}{S_t} - \frac{(1+r)p_s}{\mathbb{E}_t[S_{t+1}]}\right)}_{\text{margin (denom. in tokens) at } t\geq 2} S_{t+1}}_{\text{cash value of tokens in } t+1\geq 3} - c(e)\Bigg), \quad t \geq 2 \tag{5}$$

See, if the demand and thus the exchange rate remained constant after $t = 2$, then the margin would simplify to $m^{ICO}_{t+1} = s(p - (1+r)p_s - c(e))$ as given in Garratt and Oordt (2021). In $t = 2$, the initial token sales yields $m^{ICO}_2 = (1 - \phi)M_2\, S_2$ to the entrepreneur where S_2 is unknown in $t = 1$. The entrepreneur faces his effort decision in $t = 1$. Conditional on successful effort, his $t = 1$ expected net present value of the platform under ICO financing equals

$$NPV_1 = \sum_{t=2}^{\infty} \frac{\gamma}{(1+r)^t} \mathbb{E}_1 \left[\left(\left(\frac{p}{S_t} - \frac{(1+r)p_s}{\mathbb{E}_t[S_{t+1}]} \right) S_{t+1} - c_L \right) s_t \right] + \frac{(1-\phi)\gamma}{1+r} \mathbb{E}_1[M_2\, S_2] - \bar{e} \tag{6}$$

By the law of iterated expectation, for all $t \geq 2$

$$\mathbb{E}_1 \left[\frac{s_t\, S_{t+1}}{\mathbb{E}_t[S_{t+1}]} \right] = \mathbb{E}_1 \left[\mathbb{E}_t \left[\frac{s_t\, S_{t+1}}{\mathbb{E}_t[S_{t+1}]} \right] \right] = \mathbb{E}_1 \left[s_t \right] \tag{7}$$

since both demand s_t and $\mathbb{E}_t[S_{t+1}]$ are measurable with respect to the natural filtration of the demand process (are known in t).[1] Plugging in for the market-clearing exchange rate (4), we can further simplify

$$\mathbb{E}_1 \left[\frac{s_t\, S_{t+1}}{S_t} \right] = \mathbb{E}_1 \left[s_{t+1}\, \frac{M_t}{M_{t+1}} \right] \tag{8}$$

The entrepreneur faces his effort decision in $t = 1$ where the exchange S_2 and the token supply M_2 are still unrealized. We have $\mathbb{E}_1[M_2\, S_2] = p\, \mathbb{E}_1[s_2]$. Moreover, if demand follows a martingale, then $\mathbb{E}_1 \left[s_t \right]$ is constant in t, $t \geq 2$. Then, the efficient effort level is set if

$$NPV_1 = \sum_{t=2}^{\infty} \frac{\gamma}{(1+r)^t} \left(p\, \mathbb{E}_1 \left[s_{t+1}\, \frac{M_t}{M_{t+1}} \right] - \left((1+r)p_s - c_L \right) \mathbb{E}_1 \left[s_2 \right] \right) + \frac{\gamma}{1+r} (1-\phi) p\, \mathbb{E}_1[s_2] \geq \bar{e} \tag{9}$$

Comparing the efficient effort choice (2) with the effort choice under the ICO (9), we see that, as in Garratt and Oordt (2021), the one-period delay due to the token-in-advance constraint impacts the entrepreneur's effort decision: The summation over revenue starts one period later, and the retailers' reservation value is increased from p_s to $p_s(1+r)$. But beyond that, the stochasticity of demand and the variation in the token supply here play an important role for the entrepreneur's effort decision. Generically, we would assume that the platform demand is not independent of the time-t token supply M_t. As tomorrow's demand s_{t+1} is expected to increase, thus increasing tomorrow's exchange rate via (4), fewer token investors will supply tokens today and rather sell them tomorrow at the expected higher exchange rate, $M_t < M_{t+1}$ (hodling).[2] Therefore, one may assume that future product demand covaries negatively with the inverse change in the token supply.[3]

$$\mathbb{E}_1 \left[s_{t+1}\, \frac{M_t}{M_{t+1}} \right] = \mathbb{E}_1 \left[s_2 \right] \qquad \underbrace{\mathbb{E}_1 \left[\frac{M_t}{M_{t+1}} \right]}_{\substack{\text{expected inverse change} \\ \text{in token supply}}} \qquad + \underbrace{cov_1 \left(s_{t+1}, \frac{M_t}{M_{t+1}} \right)}_{\leq 0} \tag{10}$$

In particular, $\mathbb{E}_1 \left[s_{t+1}\, \frac{M_t}{M_{t+1}} \right] \neq \mathbb{E}_1 \left[s_2 \right]$. Conditional on a launch, ICO investors can cash out by selling tokens. In a competitive funding market, ICO investor invest in $t = 0$ if

$$I_0 = \phi\, \mathbb{E}[M_2 S_2 \mathbf{1}_{\{\text{launch}\}}] = \phi p\, \mathbb{E}[s_2 \mathbf{1}_{\{\text{launch}\}}] = \phi p\, \mathbb{E}[s_2 \mathbf{1}_{\{(9) holds\}}] \tag{11}$$

So far, we can see two implications of ICO financing that were not visible in the constant demand-

[1] Note, for this step, we do not require demand s_t to be independent of the exchange rate S_{t+1}.
[2] In fact, exactly this high token supply tomorrow will then, in return, drive down tomorrow's exchange rate.
[3] Vice versa, if tomorrow's demand is expected to be low, many agents will sell off their tokens already today.

constant token supply model of Garratt and Oordt (2021):

Result Ia [Variation in the token supply is a risk factor under ICO financing]: Even if the entrepreneur retains almost all tokens that he created in $t = 0$, $\phi \to 0$, as soon as he sells tokens to the public in $t = 2$ he faces exposure towards fluctuations in the token supply. Such fluctuations affect his NPV twofold via (i) the token exchange rate and by (ii) correlation between the token supply and platform demand. Thus, his effort choice in $t = 1$ does generically not reach the first best level even if retailers required no additional compensation for the time value of money (i.e. sold at p_s instead of $p_s(1+r)$).

Result Ib [Exchange rate variation is harmful]: Low token exchange rates do not necessarily harm the entrepreneur as long as their variation is sufficiently small. Large unexpected volatility in the token exchange rate is problematic since retailers would trade products for tokens today whose value tomorrow may deviate much from the initially set (fiat) price $\frac{p_s}{\mathbb{E}_t[S_{t+1}]} S_{t+1} \neq p_s$. Large volatility in the exchange rate can, therefore, cause platform retailers to exit, which destroys the entrepreneur's source of profit margin.

For models on dynamic token evaluation, see for instance Cong et al. (2021); Li and Mann (2018); Prat et al. (2019).

3.2 Debt Financing

Assume now instead, the entrepreneur borrows I_0 from debt investors (a bank) and promises to repay $D > I_0$ in the future, where D denotes the time $t = 2$ present value of debt, as in Garratt and Oordt (2021). Implicit is here the assumption that debt repayments can be staggered over a longer time horizon similarly to a bond's coupon payments. The entrepreneur is solvent at time $\tau \geq 1$ only if

$$\gamma \sum_{t=1}^{\tau-1} s_{t+1}(p - p_s - c_L)(1+r)^{(\tau-1)-t} + \gamma\,\mathbb{E}_\tau \left[\sum_{t=\tau}^{\infty} \frac{s_{t+1}(p - p_s - c_L)}{(1+r)^{t-(\tau-1)}} \right] - \frac{D}{1+r} \geq 0 \tag{12}$$

where we set the first sum equal to zero for $\tau = 1$. Otherwise, the entrepreneur defaults on his debt at time τ. The formulation (12) assumes that if platform revenue aggregated up until time τ realizes below a scheduled debt repayment, the entrepreneur can take on a new loan for making the scheduled repayment by pledging future platform revenue as collateral. The new loan will be issued, as long as the expected present value of future platform revenue jointly with already realized platform revenue exceeds the borrowed amount.

By limited liability, the entrepreneur's time-1 net present value under debt financing equals

$$NPV_1 = \gamma\,\mathbb{E}_\tau \left[\max\left(\sum_{t=1}^{\infty} \frac{s_{t+1}(p - p_s - c_L)}{(1+r)^t} - \frac{D}{1+r}, 0 \right) \right] \tag{13}$$

Define the critical demand default threshold

$$Z(D) = \frac{D}{(1+r)(p - p_s - c_L)} \tag{14}$$

and the platform's discounted lifetime demand

$$\hat{S} = \sum_{t=1}^{\infty} \frac{s_{t+1}}{(1+r)^t} \tag{15}$$

Then, the effort incentive constraint in $t = 1$ becomes

$$NPV_1 = \gamma(p - p_s - c_L)\,\mathbb{E}_1\left[\max\left(\hat{S} - Z(D), 0\right)\right] \geq \bar{e} \tag{16}$$

or equivalently

$$\mathbb{E}_1\left[\left(\hat{S} - Z(D)\right)\mathbf{1}_{\{\hat{S}>Z(D)\}}\right] \geq \frac{\bar{e}}{\gamma(p - p_s - c_L)} \tag{17}$$

If the stochastic discounted lifetime demand for the platform product realizes above the critical threshold Z, the entrepreneur will be able to repay his debt, and remains solvent and in control of the platform. The entreprenenuer's net present value can be calculated using an option pricing approach à la Merton (1974) where the underlying is given by the discounted lifetime platform demand $\hat{S}$.

At time zero, debt investors are willing to lend I_0 at a gross interest rate D if

$$I_0 \leq \frac{\gamma}{(1+r)^2}\,\mathbb{E}_0\left[\min\left(\sum_{t=1}^{\infty} \frac{s_{t+1}(p - p_s - c_L)}{(1+r)^t}, \frac{D}{1+r}\right)\mathbf{1}_{\{\text{effort in t1}\}}\right] \tag{18}$$

$$= \frac{\gamma(p - p_s - c_L)}{(1+r)^2}\,\mathbb{E}_0\left[\min\left(\hat{S}, Z(D)\right)\mathbf{1}_{\{(17)\ holds\}}\right] \tag{19}$$

In a competitive debt market, the inequality (18) will hold with equality such that a fixed investment I_0 will require a specific interest rate D. As the initial investment I_0 increases, the interest rate D at which debt investors are willing to lend must increase. Simultaneously, however, also the default threshold $Z(D)$ goes up such that the entrepreneur's default becomes more likely (the indicator $\mathbf{1}_{\{\hat{S}>Z\}}$ is positive less often). The increased default likelihood, on the other hand, reduces the entrepreneur's willingness to put effort via (17). Comparing the incentive-effort condition under an ICO (9) to the condition under debt financing (16), we see:

Result II [ICO financing yields [partial] insurance against demand and default risk]:
(a) Stochastic demand causes default risk under debt financing. Stochastic demand does not cause default risk under ICO financing.
(b) In particular, ICO financing provides partial insurance against low platform demand realizations.

On (a), the reason why default risk is absent under ICO financing stems from our assumption that costs are not fixed but monotone in platform demand. As demand declines, so does the cost of running the platform. When taking into account fixed costs, stochastic demand will also cause default risk under ICO financing. On (b), while under debt financing, the entrepreneur would be forced to default once discounted lifetime demand realizes below the default boundary Z, the ICO entrepreneur remains in business also for $\hat{S} < Z$. Perpetual low demand realizations under ICO financing 'only' lead to lower margins and lower exchange rate realizations via (4). ICO investors bear a proportion of the demand risk since the cash flow they receive when exiting at the date of the platform launch is not a hard claim.

Instead, ICO investors exit at an ex ante random exchange rate which declines in the platform demand realization. That is, ICO investors face exchange rate risk since the token might be less valuable at the exit stage than expected at the financing stage. This would in particular be the case, if the platform never launches so that tokens had a value of zero. In contrast, under debt financing, the entrepreneur faces a fixed debt claim and default even if the platform never launches. Because default and demand risk are reduced under ICO financing in contrast to debt financing, it is intuitive that the entrepreneur may put more effort into reducing platform expenses under an ICO than with credit.

3.3 Venture Capital Financing

To contrast venture capital with ICO financing, assume, VC investors demand a share $\omega \in (0,1)$ of future platform revenue in return for an initial investment I_0. Then, the $t = 1$ effort incentive constraint for the entrepreneur requires

$$\sum_{t=1}^{\infty} \frac{\gamma\, \mathbb{E}_1[s_{t+1}](p - p_s - c_L)}{(1+r)^t}(1-\omega) \geq \bar{e} \tag{20}$$

Because s_t is a martingale, we have for $t \geq 1$, $\mathbb{E}_1[s_{t+1}] = \mathbb{E}_1[s_2]$. Under VC financing, the entrepreneur, therefore, puts effort into improving platform performance only if expected demand exceeds

$$\mathbb{E}_1[s_2] \geq \frac{1}{1-\omega} \frac{r\bar{e}}{\gamma(p - p_s - c_L)} =: s_{VC}(\omega) = \frac{1}{1-\omega}\, s^* \tag{21}$$

What is the VC capitalist's individual rationality constraint for investing I_0 in return for a stream ω of future revenue, where revenue is generated starting in $t = 2$? In a competitive venture capital market, a given investment I_0 requires the share ω to satisfy

$$I_0 = \omega \sum_{t=2}^{\infty} \frac{\gamma(p - p_s - c_L)}{(1+r)^t}\, \mathbb{E}_0[s_t \mathbf{1}_{\{effort\}}] \tag{22}$$

$$= \frac{\omega}{(1+r)} \sum_{t=1}^{\infty} \frac{\gamma(p - p_s - c_L)}{(1+r)^t}\, \mathbb{E}_0[s_{t+1} \mathbf{1}_{\{\mathbb{E}_1[s_2] \geq s_{VC}(\omega)\}}] \tag{23}$$

$$= \frac{\gamma(p - p_s - c_L)}{r(1+r)}\, \omega\, \mathbb{E}_0[s_2 \mathbf{1}_{\{\mathbb{E}_1[s_2] \geq s_{VC}(\omega)\}}] \tag{24}$$

where the last step follows from the law of iterated expectations, because the indicator $\mathbf{1}_{\{\mathbb{E}_1[s_2] \geq s_{VC}(\omega)\}}$ is $\mathcal{F}_1-$measurable, and because demand is a martingale, and therefore has constant mean.

$$\mathbb{E}_0[s_{t+1} \mathbf{1}_{\{\mathbb{E}_1[s_2] \geq s_{VC}(\omega)\}}] = \mathbb{E}_0[\mathbb{E}_1[s_{t+1}] \mathbf{1}_{\{\mathbb{E}_1[s_2] \geq s_{VC}(\omega)\}}] = \mathbb{E}_0[\mathbb{E}_1[s_2] \mathbf{1}_{\{\mathbb{E}_1[s_2] \geq s_{VC}(\omega)\}}] = \mathbb{E}_0[s_2 \mathbf{1}_{\{\mathbb{E}_1[s_2] \geq s_{VC}(\omega)\}}] \tag{25}$$

A larger initial investment I_0 will cause VC investors to demand a larger equity stake ω. On the other hand, a larger stake ω increases the risk that the platform is not launched since the cut-off $s^*(\omega)$ increases in the stake ω. Therefore, in line with the findings of Garratt and Oordt (2021),

Result III a [VC versus ICO]: Under venture capital financing, the lower the entrepreneur's ownership stake in the platform the lower the entrepreneur's incentive to put effort. Under ICO financing, even if the entrepreneur sells all tokens in $t = 0$ by setting $\phi = 1$, he will generate revenue in the following periods since he essentially charges a retail revenue-dependent tax.

Result III b [VC Ownership versus Token Ownership]: Under venture capital financing, the entrepreneur loses revenue by shared firm ownership. Under ICO financing, the entrepreneur's revenue is continuously exposed to the behavior of token owners, and in particular, token speculation.

See that the entrepreneur's margin under an ICO (5) assumes that prices at the platform are quoted in fiat money so that the token price for a platform product varies with the exchange rate. While under an ICO the entrepreneur does not share ownership of the platform with ICO investors, his platform revenue (9) is substantially exposed to token speculation, i.e., the behavior of token owners. Investors may hold back tokens, and thus drive up the exchange rate which will reduce the entrepreneur's margin (5) if the exchange rate falls back quickly. The behavior of token owners impact the entrepreneur's revenue in a stochastic way. In contrast, under venture capital financing, the reduced ownership share reduces the entreprenenur's revenue in a predictable, non-stochastic way.

Result IV [Under ICO financing: Revenue is non-monotonic in demand acrosss time] Under both venture capital and debt financing, an expected increase in demand s_t at time t always leads to an expected increase in the entreprenenur's revenue at t. Under ICO financing, in contrast, an expected increase in demand may lead to an instantaneous increase in revenue today and can cause strategic changes in the token supply (speculation) which may adversely affect the exchange rate and future revenue in the period of high sales, see (8) and (9).

The latter effect is due to market efficiency (Fama et al., 1969): positive news on future demand can cause investors to already hold tokens back today, or increased token demand. The reduced token supply then causes an increase in the exchange rate already today. But in the period where sales is then indeed high, the exchange rate may be low since already other, potentially bad news have arrived in the market in the mean time.

Since future high demand translates into a high exchange rate and higher margins already today, this also means that such positive news on demand are discounted less under ICO financing. Under debt and venture capital financing, future high demand leads to future high margins, which are then discounted highly since they arrive later.

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